Jan. 30, 1968 R. F. MALLINA 3,366,301

INSTRUMENT FOR JOINING BLOOD VESSELS

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Fig. 1.

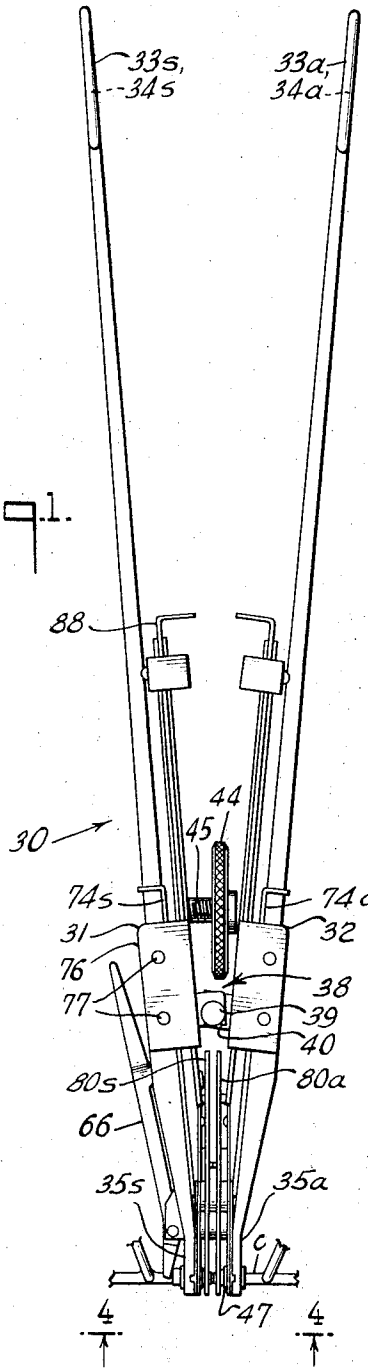
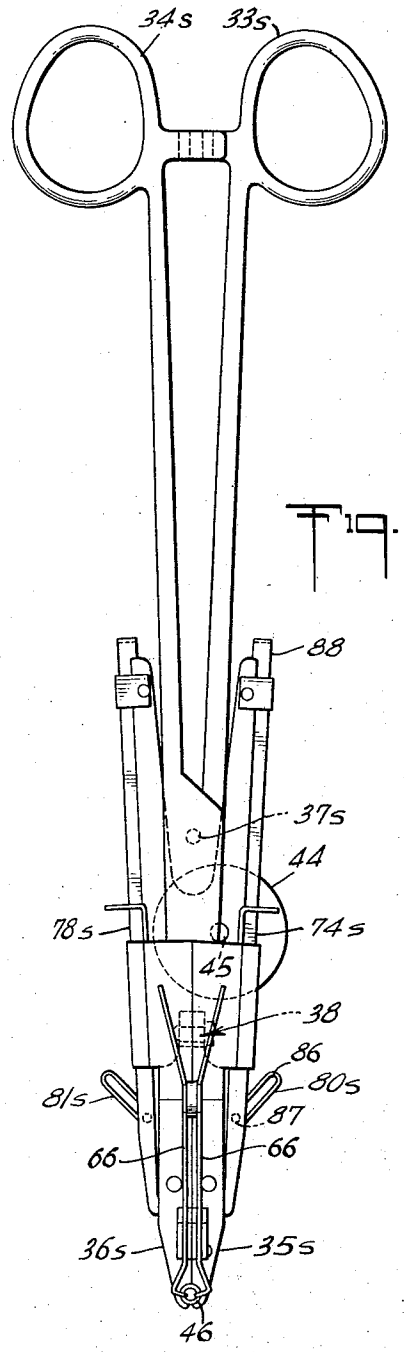


Fig. 2.



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INSTRUMENT FOR JOINING BLOOD VESSELS

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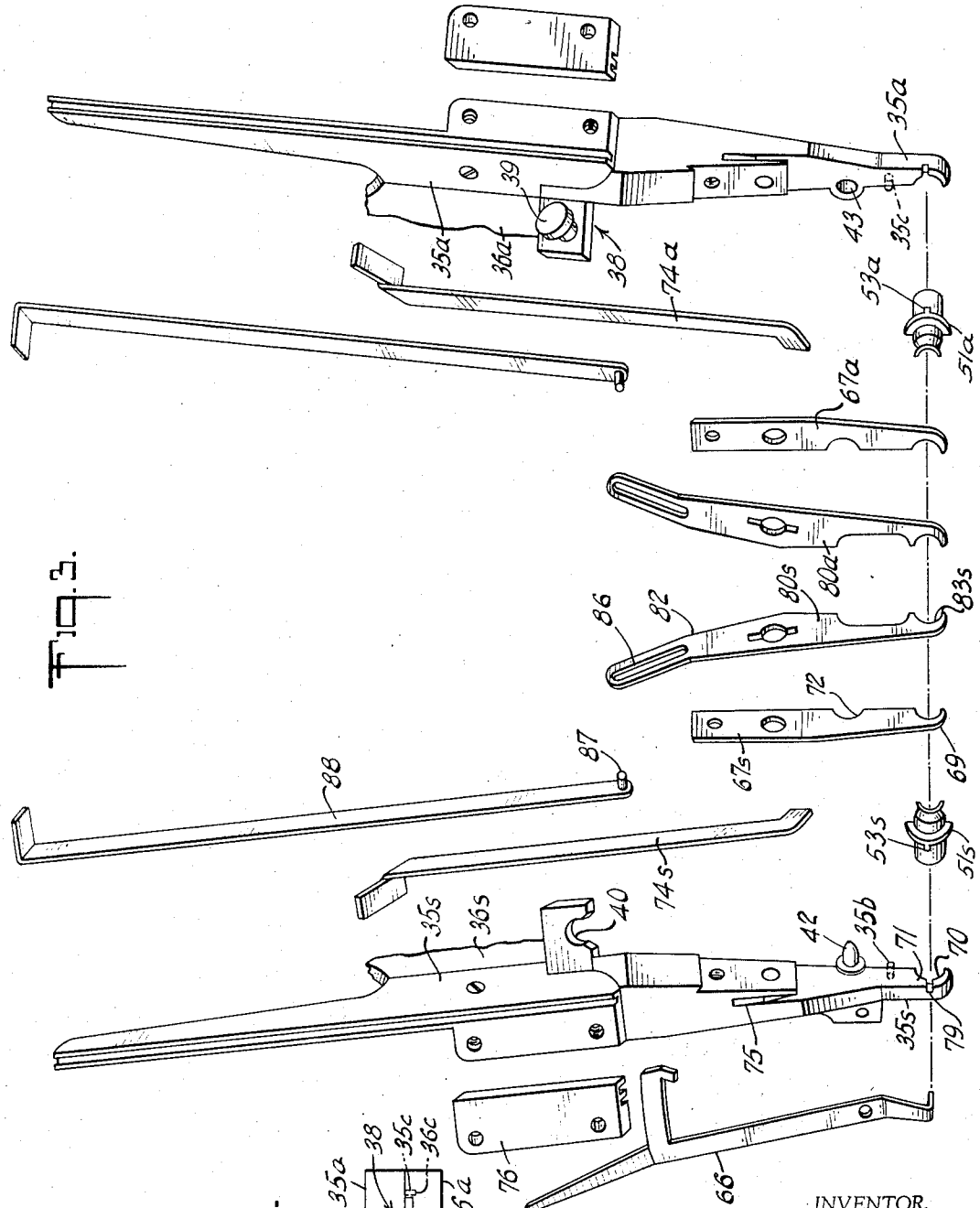


FIG. 3.

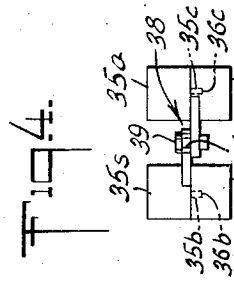


FIG. 4.

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INSTRUMENT FOR JOINING BLOOD VESSELS

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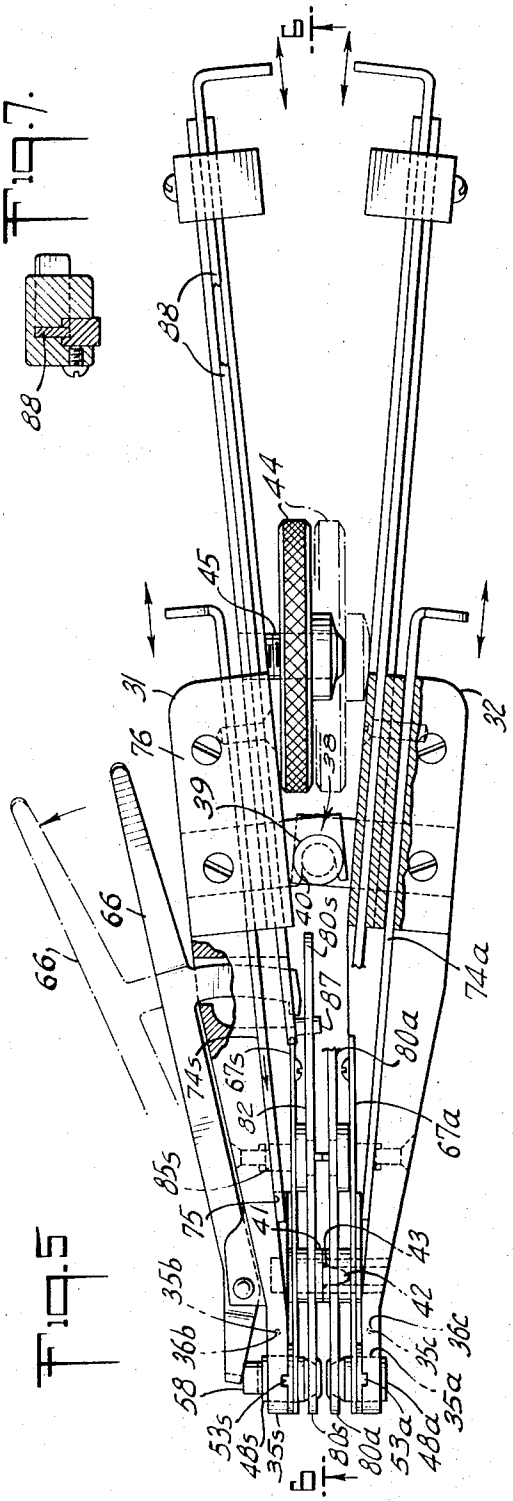


FIG. 5.

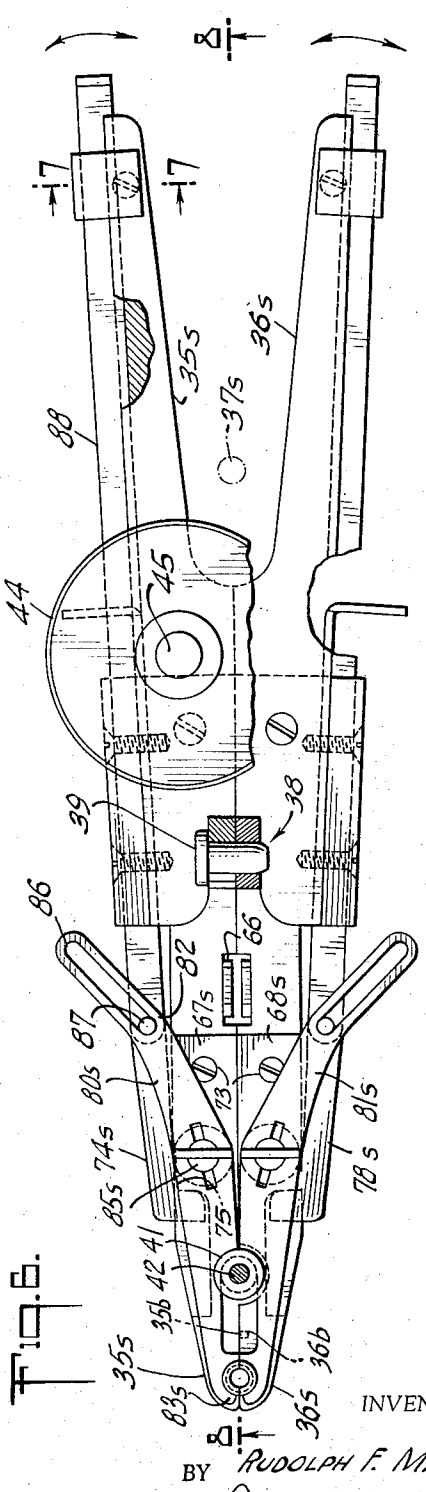


FIG. 6.

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INSTRUMENT FOR JOINING BLOOD VESSELS

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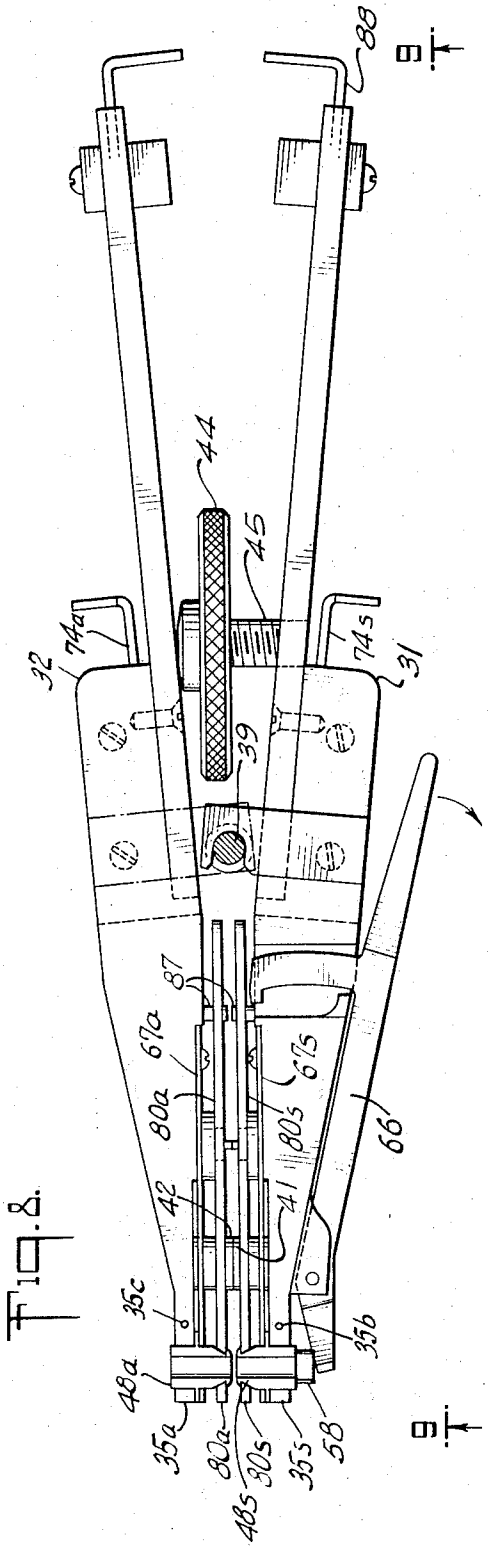


FIG. 8.

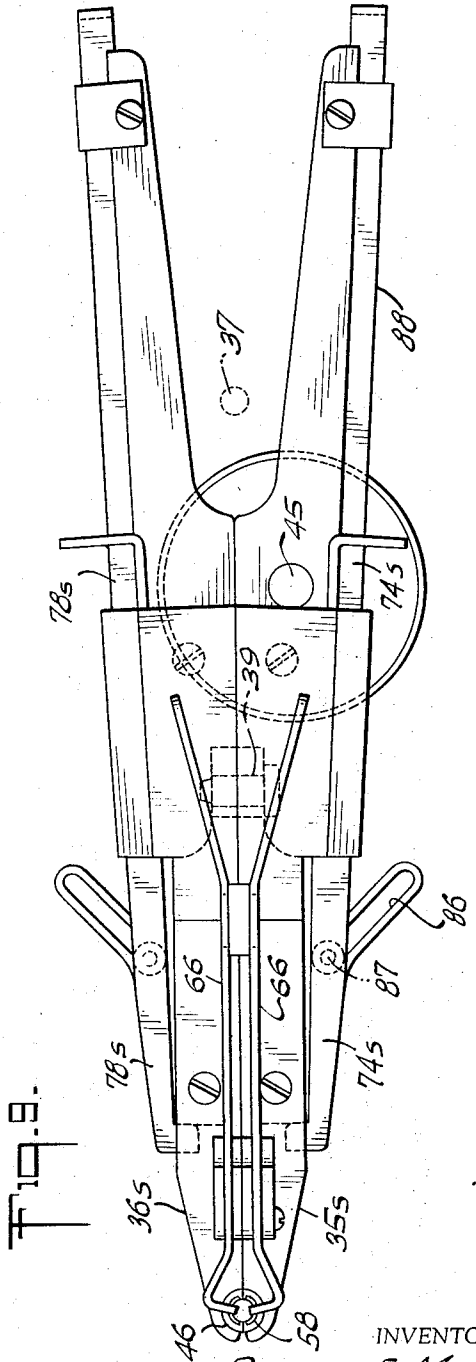


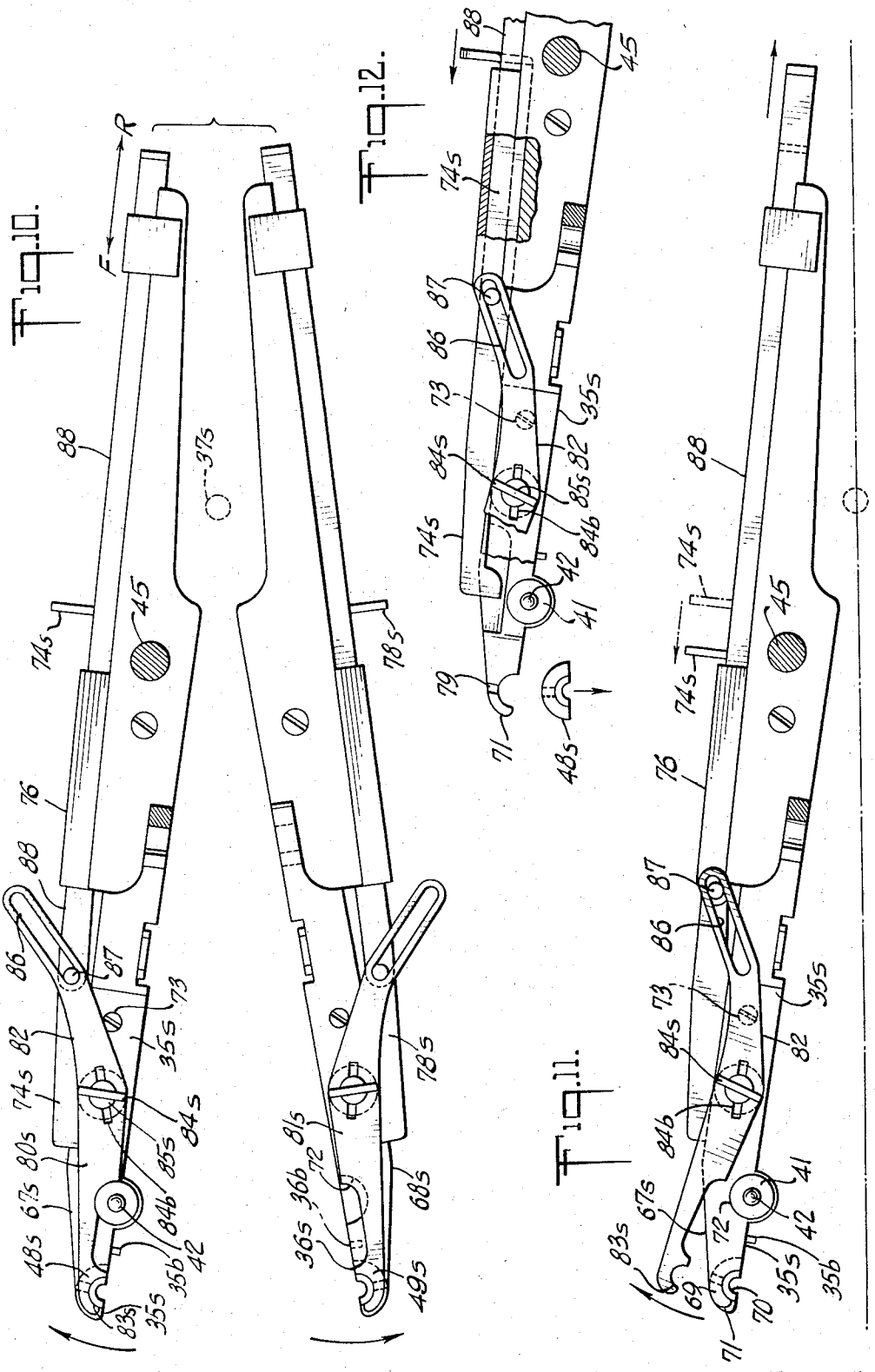
FIG. 9.

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INSTRUMENT FOR JOINING BLOOD VESSELS

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Fig. 13.

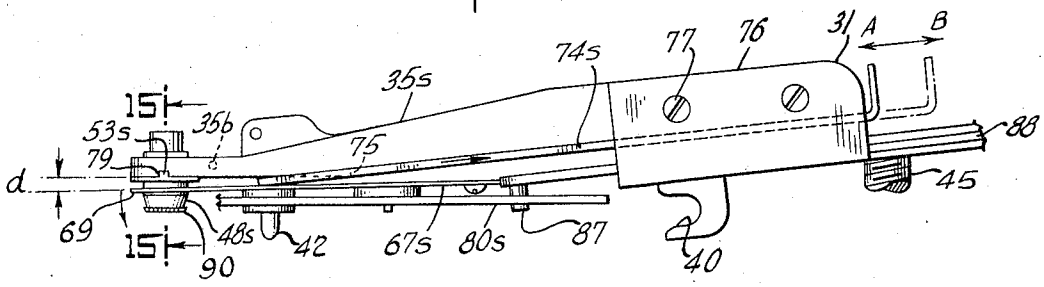


Fig. 14.

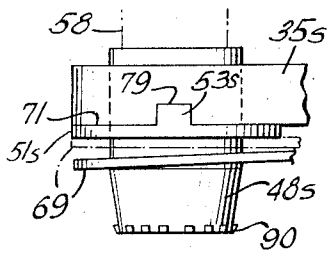


Fig. 15.

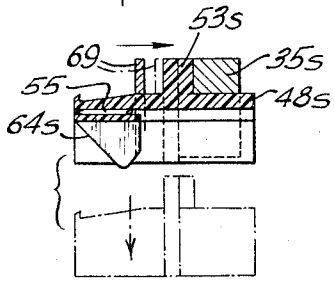


Fig. 17.

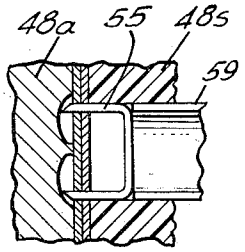


Fig. 16.

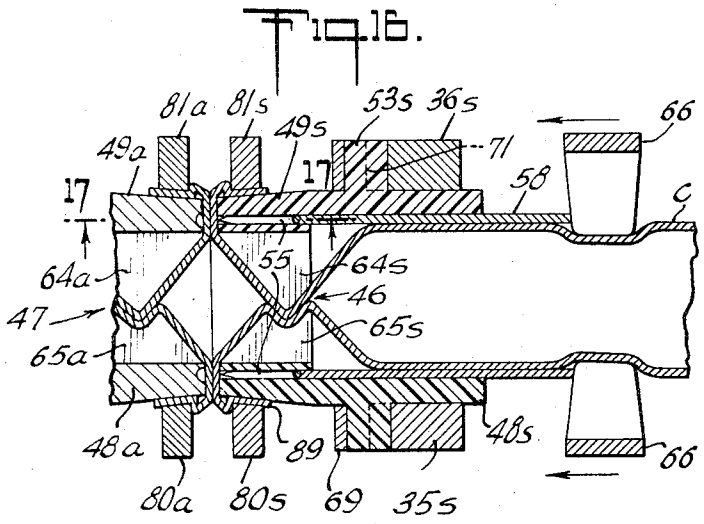
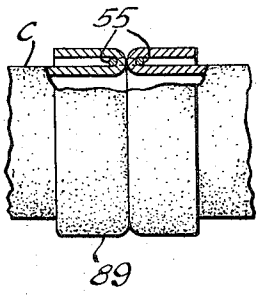


Fig. 18.



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Jan. 30, 1968 R. F. MALLINA 3,366,301

INSTRUMENT FOR JOINING BLOOD VESSELS

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Fig. 19.

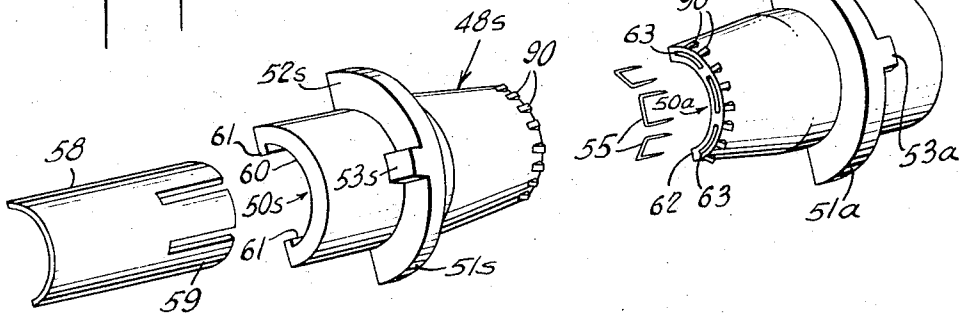


Fig. 21.

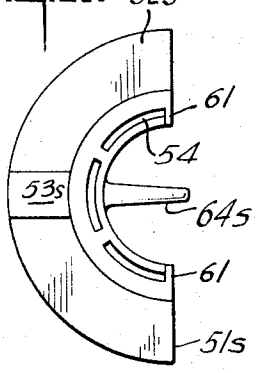


Fig. 20.

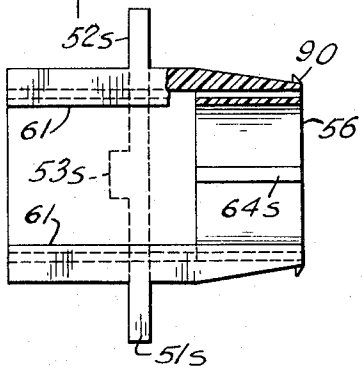


Fig. 22.

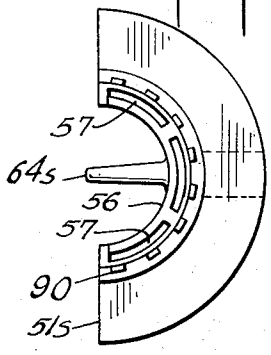
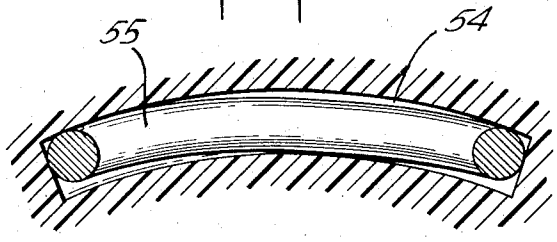


Fig. 23.



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United States Patent Office 3,366,301
Patented Jan. 30, 1968

3,366,301

INSTRUMENT FOR JOINING BLOOD VESSELS

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Filed Sept. 7, 1965, Ser. No. 485,246
7 Claims. (Cl. 227—19)

ABSTRACT OF THE DISCLOSURE

A medical instrument useful in the anastomosis of small blood vessels is constructed in two sections. One end of a blood vessel to be joined is cuffed over a staple bushing held by one section of the instrument, and the other end of the blood vessel is cuffed over an anvil bushing held by the other section of the instrument. The two sections are then coupled together whereby the two cuffed vessel ends are aligned with the intima of the vessel ends in contact. A stapler lever is then actuated to drive staples through the coupled ends.

This invention relates to surgical instruments, and relates more particularly to medical stapling instruments or staplers for the anastomosis of circulatory vessels, such as the joining of blood vessels and similar linear structures such as lymphatics and the like.

The most conventional way of reconnecting a severed blood vessel is by manual suturing, in which the surgeon uses a curved needle with a silk thread attached and held in specially designed forceps to sew the ends of a vessel together for re-establishing therein the flow of blood. In large vessels, this type of anastomosis, however time consuming and demanding of surgical skill, produces a reasonably satisfactory connection between the two vessel ends. For small vessels, however, this type of connection becomes difficult; for very small blood vessels, which may have a diameter of 2 mm. or smaller, suturing of the ends by hand is a difficult and often impossible task.

It is accordingly among the principal objects of the invention to provide a stapler with the aid of which the ends of circulatory vessels may be reconnected safely and reliably, equally well for large, for small, and even for very small vessels.

Reference is made to my U.S. Patent No. 3,144,654 for a detailed description of the various parts of a vascular stapling instrument and the use of such an instrument in the anastomosis of blood vessels.

Reference is also made to my U.S. Patent No. 3,176,896 for a detailed description of bushing parts for use in connection with a stapling instrument.

The use of a mechanical stapling instrument simplifies the end to end anastomosis of blood vessels and offers the advantages over hand suturing of reduced operation time and improved uniformity. One of the most difficult steps in the anastomosis with a stapler is the cuffing of the vessel over the bushing rim. In my Patent No. 3,144,654 referred to above, the cuff is held in position by what might be termed a "universal" cuffing clamp. Only two points of the cuffing clamp hold the cuff on the bushing half. The design of a single cuffing clamp to accommodate all bushing sizes requires a compromise that favors the middle size bushings at the expense of the larger and smaller bushings.

It is an advantage of the present invention that the cuffing clamp contacts the cuffed vessel, not at two points per bushing half, but throughout the entire 180° angle of the bushing half. The design of this improved cuffing clamp is such that it may be easily and quickly mounted on the jaw of the instrument to permit the accommodation

of a specific bushing and vessel size. The present invention further provides a cuffing clamp that may be manipulated by the surgeon or his assistant at a distance from the circulatory vessel being repaired. The main purpose for removing the control points toward the rear of the instrument is the fact that during the cuffing of the vessel, the operating surgeon has both hands right over the tip of the instrument. This leaves hardly any room for the assisting surgeon to get his hands in a position so he can open and close the cuffing clamps. This is particularly awkward in deep cavities. Bringing the controls only a few inches back toward the handle allows the assisting surgeon to operate the cuffing clamps with ease and without interferring with the hands of the operating surgeon.

In the vascular stapler described in my issued patent it is necessary to move the stapler section and anvil section of the instrument from an upper plane to a lower plane to couple them. In coupling the instrument to be described herein, the surgeon may confine his coupling motions to a single plane. This improves the ease of coupling and enables the surgeon to see better what he is doing.

The present invention also provides an improved locking means for the bushing parts with relation to the stapler. It is an advantage of the locking means to be described herein that it minimizes the obstruction of the surgeon's view and facilitates the anastomosis of very small blood vessels.

In the accompanying drawings:

FIGURE 1 is a plan view of a medical stapling instrument in accordance with the invention, showing the stapling section and the anvil section of the instrument with a circulatory vessel positioned for stapling;

FIG. 2 is a side elevation of FIG. 1 viewed in the direction of the stapling section, though without vessel;

FIG. 3 is an exploded view of parts of the medical stapler in perspective;

FIG. 4 is a diagrammatic representation of the medical instrument as seen in the direction 4—4 of FIG. 1 and shows the relative position of the principal parts thereof, other parts being deleted for clarity;

FIG. 5 is a top plan view of the two sections of the stapler shown in FIG. 1 in operative relationship;

FIG. 6 is a horizontal cross-section taken on the line 6—6 of FIG. 5, showing the stapling section of the instrument;

FIG. 7 is an enlarged vertical detail section taken on the line 7—7 of FIG. 6;

FIG. 8 is an inverted plan view taken on the line 8—8 of FIG. 6 showing both the stapling and anvil sections;

FIG. 9 is an elevation of FIG. 8 viewed in the direction 9—9;

FIG. 10 is a view similar to FIG. 6 with the jaws of the stapling section in open position;

FIG. 11 is a view similar to FIG. 10 showing only the upper half thereof and the cuffing lever in open position;

FIG. 12 is a detailed fragmentary view of the stapling section shown in FIG. 11 with portions broken away to show the bushing release mechanism;

FIG. 13 is a top plan view of the stapling section illustrated in FIG. 12;

FIG. 14 is an enlarged fragmentary view of a portion of FIG. 13;

FIG. 15 is an enlarged section taken on the line 15—15 of FIG. 13;

FIG. 16 is a fragmentary large scale elevation view partly in section, showing two vessel ends about to be stapled;

FIG. 17 is a fragmentary large scale developed view in section on the line 17—17 of FIG. 16;

FIG. 18 is a fragmentary large scale elevational view partly in section, showing two stapled vessel ends;

FIG. 19 is an extended view, in perspective of one staple bushing part with staples and a staple driver, and one anvil bushing part;

FIG. 20 is an interior view of a bushing half;

FIG. 21 is an end elevation of FIG. 20 as seen from the left;

FIG. 22 is a view similar to FIG. 21 looking from the right; and,

FIG. 23 is a fragmentary large scale sectional view of a staple positioned in a bushing.

THE STAPLER—GENERAL DESCRIPTION

The embodiment of this invention which has been selected for description in this specification is illustrated in the accompanying drawings, and particularly in FIGS. 1, 2 and 4 which show a medical stapling instrument or stapler **30** having two sections, namely a stapler section **31** and an anvil section **32**. It will be noted that the stapler section **31** comprises a pair of forceps having two releasably interengaging handles **33***s*, **34***s* and jaws **35***s*, **36***s* pivoted at **37***s*. As best shown in FIG. 10, a register pin **35***b* on the jaw **35***s* and an aperture **36***b* on the jaw **36***s* are provided for locating and properly positioning the jaws relative to each other when in the closed position. The anvil section comprises a pair of forceps having releasably interengaging handles **33***a* and **34***a* and jaws **35***a*, **36***a* corresponding to jaws **35***s* and **36***s*. A register pin **35***c* on the jaw **35***a* and an aperture **36***c* on the jaw **36***a* are provided for locating and properly positioning the jaws relative to each other when in the closed position (see FIG. 2). The relative position of each pair of forceps when the stapler section **31** is joined to the anvil section **32** is illustrated in FIG. 4.

The foregoing and some other parts mentioned subsequently herein are either identical with, or similar to corresponding parts in the aforesaid earlier patents, No. 3,144,654 and No. 3,176,896; and wherever the discussion of these parts in the said earlier applications is more detailed than herein, such fuller discussion is incorporated herein by reference.

The stapler section **31** is releasably engaged with the anvil section **32** by hinge means **38** consisting of a headed pin **39** and a slot **40** shaped to receive releasably the pin **39**. The pin **39** is rotatable relative to the slot **40** when inserted therein. As best shown in FIGS. 5 and 13, registry means **41** are provided for locating and properly positioning the front parts of the sections **31** and **32** relative to each other, and may include a register pin **42** on the one section and an aperture **43** on the other.

The two sections will be separate from each other during cleaning, sterilizing and mounting of the ends of a circulatory vessel such as a blood vessel, but after each vessel end is engaged on a section, the surgeon or other operator, as more fully explained below, will interengage the sections **31** and **32** by the hinge means **38** before proceeding with the actual stapling.

Adjustable means are provided, such as a nut **44** and screw **45**, for adjusting the force with which the two front ends of the sections **31** and **32** are pressed together, in order to regulate the pressure with which the parts of the vessel to be stapled are held in contact.

THE BUSHINGS

Each section of the instrument carries a bushing. The stapler section **31** carries a stapler bushing **46**, and the anvil section **32** an anvil bushing **47**.

Thus, as shown in FIGS. 8, 10 and 16, there is disposed in the upper jaw **35***s* of the stapler section **31** an upper staple bushing-half **48***s*, and in the lower jaw **36***s* of the stapler section **31** there is disposed lower stapler bushing-half **49***s*. Similarly, in the upper jaw **35***a* of the anvil section **32** there is disposed an upper anvil bushing-half **48***a* and in the lower jaw **36***a* there is disposed a lower anvil bushing-half **49***a*. The pair of upper and lower bushing-halves **48***s* and **49***s*, and the pair of bushing-halves **48***a* and **49***a*, each completes in its section a bushing; thus the bushing-halves **48***s* and **49***s* complete the staple bushing **46**, and the bushing-halves **48***a* and **49***a* complete the anvil bushing **47**.

As best shown in FIGS. 19–22 each staple bushing-half has an internal cavity **50***s* and has on its exterior surface a flange **51***s* having on one face **52***s* thereof a projection **53***s* which may be molded integral with the bushing. Each staple bushing-half has on its interior one or more receptacles **54**, each having staples **55**. The receptacle intersects the front face **56** of the bushing-half in an arcuate aperture or apertures **57** which form the staple exit port or ports. A staple driver **58** is provided which has two or more fingers **59** reaching into each receptacle **54** to expel the staples **55** out of the respective ports **57**. The driver **58**, of the upper bushing-half **48***s*, is retained between the curved inner surface **60** of the bushing-half **48***s* and the guide rails **61** thereof, while the fingers **59** will protrude with their forward portions into the receptacles **54**.

The anvil bushing-halves have an internal cavity **50***a* and on their exterior surface a flange **51***a* having on one face **52***a* thereof a projection **53***a*. Each anvil bushing-half is provided at its front face **62** with a hard surface in which the clinching grooves **63** are formed.

Each bushing **46** and **47** when assembled for stapling has an interior passage for one end of a circulatory vessel defined by the inner curved surface **60** of the cavities **50***s* and **50***a*. An upper clamp tooth **64***s* and lower clamp tooth **65***s* within the interior passage of the staple bushing have a serrated surface defining therebetween an undulating path in which there is clamped a portion of a vessel C (see FIG. 16). Each of the clamp teeth **64***s* and **65***s* is molded in one piece with its respective bushing part. While the upper stapler bushing part **48***s* generally is exactly like the lower part **49***s*, the exception is that the clamp tooth **64***s* of the upper part is complementary, rather than symmetrical, relative to the clamp tooth **65***s* of the lower bushing part. The same may be said about the parts of the anvil bushing **47**; namely, the upper and lower parts are alike except for their respective clamp teeth **64***a* and **65***a*.

As best shown in FIG. 5, the stapler section **31** includes a staple lever **66** for propelling the staple driver **60**.

LATCHING MEANS

Means are provided, such as a locking device connected to each jaw, for locking the respective bushing part. Thus the upper jaw **35***s* of the upper bushing-half **48***s* comprises a locking device **67***s* and the lower jaw **36***s* a locking device **68***s* (see FIG. 10).

As best shown in FIGS. 11–15 on the upper jaw **35***s* there is mounted a flat spring **67***s* one end **69** of which is shaped to correspond with the bore **70** of the bearing surface **71**. This spring has a circular opening **72** dimension to clear the registration means **41** and is secured to the jaw **35***s* by the screw **73**. In the closed position the end **69** of the spring **67***s* is parallel to the bearing surface **71** of the jaw **35***s* but spaced therefrom a distance slightly less than the width of the bushing flange.

A bushing slide **74***s* is slideably mounted in a slot **75** and retained in positon by a cover plate **76** fastened to the jaw **35***s* by two screws **77**.

A bushing slide **78***s* is similarly mounted on the lower stapler jaw **36***s*. The operation of the locking device on each jaw is similar and will be understood from the following description of the operation of the bushing slide **74***s*.

With reference to FIG. 13, bushing slide **74***s* is moveable in the direction of the arrow A wedging itself between the jaw **35***s* and spring **67***s* thereby lifting it a distance *d* from the bearing surface, and releasing the bushing **48***s* from the jaw **35***s*. The movement of the bushing

slide in the direction B, the position indicated in dotted lines, releases the spring **67***s* which moves to the position indicated by the dotted lines (FIG. 14), thereby locking the bushing in place. It will be noted that when the bushing **48***s* is thus secured in the jaw **35***s*, the projection **53***s* on the flange of the bushing is registered with a recess **79** in the bearing surface **71** of the jaw **35***s*.

In a similar manner the bushing slides **74***a* and **78***a* operate to lock the anvil bushing-halves **48***a* and **49***a* in the jaws **35***a* and **36***a*, respectively, of the anvil section **32**.

THE CUFFING CLAMP

Two cuffing clamps **80***s* and **81***s* are provided for the staple bushing **46** and two cuffing clamps **80***a* and **81***a* are provided for the anvil bushing **47**. The operation of each of these cuffing clamps will be understood with reference to FIGS. 10, 11 and 12 and the description of the clamp **80***s* that follows.

The cuffing clamp **80***s* comprises a lever **82** and a front portion that has an edge **83***s* that complements the exterior surface of the bushing **48***s*. The edge **83***s* may be serrated if desired. The cuffing clamp **80***s* is mounted on the jaw **35***s* by a bayonet type mounting consisting of a pivot **85***s* and a bar **84***s* that extends beyond the circumference of the pivot. This permits rapid mounting of the cuffing clamp on the jaw by an axial and rotary motion; first aligning a slot **84***b* in the cuffing clamp with the bar **84***s*. When mounted on the jaw **35***s* the top surface of the cuffing clamp is engaged by the lower surface of the bar **84***s*, and a slot **86** in the back portion of the cuffing clamp engages a pin **87**. The pin **87** may be moved by a cuffing slide **88** mounted in a channel on the jaw **35***s* by a retainer of well known conventional construction shown in FIG. 7. At that end of the cuffing slide most remote from the pin **87**, there is a handle. That end of the cuffing slide nearest to the pin is retained by the same cover plate **76** that retains the bushing slide **74***s* referred to above in describing the latching means. The cuffing slide **88** is moveable by its handle in opposite directions R and F between a rearward and forward position (the forward position being shown in FIG. 10 and the rearward position in FIG. 11). Moving the slide to its rearward position opens the cuffing clamp and removes it from the immediate field of the vessel, thereby permitting the surgeon to freely manipulate the vessel and form a cuff on the bushing. The cuffing slide may then be moved to its forward position closing the cuffing clamp to contact the cuffed vessel, and hold it in place against the bushing.

MATERIALS

The material of the bushing parts **48***s* and **49***s* is preferably a non-metallic molded material, for instance a crystalline thermoplastic acetal resin having a high melting point and known under the trademark "Delrin," or other heat and chemically stable material. The entire anvil bushing **47** may be made of metal such as stainless steel or other hard material, for instance glass. It also may be a metal coated plastic.

The staple driver **58** may be made of stainless steel or a cobalt chromium known under the trademark "Vitalium." Likewise, the parts of the forceps as well as the stapling lever **66** and the cuffing clamp may be made of stainless steel or "Vitalium" or of some similar biologically inert material.

THE OPERATION OF THE MEDICAL STAPLER

Each bushing-half is positioned in its respective open jaw of the forceps, and is locked in position by moving the cam levers, **74***s*, **74***a*, **78***s* and **78***a*, in the direction B to the rearwardmost position indicated in dotted lines in FIG. 13. Thereafter, one of the severed ends of the vessel C is introduced between the two halves **48***s*, **49***s* of one bushing **46**, and the other end between the two halves **48***a*, **49***a* of the other bushing **47**.

Then the surgeon will close the jaws of the stapler section and the anvil section by bringing together and interlocking the handles of each section. By this closing, each of the two bushing-halves will complete the respective bushing, and the vessel clamping means, **64***s*, **65***s* and **64***a*, **65***a*, thereof will clamp a portion of the vessel, as shown in FIG. 16.

Thereafter the vessel end will be turned over the bushing as illustrated in FIG. 16 to form a cuff **89**, the vessel being retained on the bushing by the teeth **90**. Subsequently, the cuffing clamps **80***s*, **81***s*, **80***a*, **81***a* are applied.

Thereafter the two sections **31** and **32** are coupled together by the hinge means **38** and registered with the registering means **41**; the force between the two cuffed vessel ends being adjusted by means of the adjustable nut **44**.

The surgeon will now apply the staple lever **66**, so that the staples **55** will be driven through the adjoining cuffed vessel ends.

Thereafter the operator will open the cuffing clamps, release the bushings **48***s*, **49***s*, **48***a*, **49***a* from the jaws **35***s*, **36***s*, **35***a*, **36***a*, and spread apart the handles **33***s*, **34***s*, and **33***a*, **34***a*. When the jaws have been opened and the stapling instrument removed the cuffs may be turned back and the bushing-halves removed from the site of the anastomosis. The joined blood vessel ends are shown in FIG. 18.

I wish it to be understood that I do not desire to be limited to the exact details of construction shown and described, for obvious modifications will occur to a person skilled in the art.

What is claimed is:

1. In a suturing stapler having forcep means, in combination, two bushings each comprising two opposite parts positionable on the forceps means and defining on its interior a central passage for one end of a severed circulatory vessel, means operable for holding releasably each severed end of the vessel cuffed over a bushing comprising two cuffing clamps for each bushing operable to engage the cuff on opposite sides of the outer bushing surface, each cuffing clamp having a cuff engaging edge at one end thereof, and being pivoted on the forceps means about a fulcrum, the other end of each cuffing clamp extending beyond the fulcrum and having a slot therein that defines an angle with respect to the axis of the forceps; a pin engaging said slot, said pin being mounted at one end of a slide that is moveable in a direction parallel to the principal axis of the forceps and extends a substantial distance back from the cuffing clamp thereby permitting manipulation of the slide and rotation of the cuffing clamp about the fulcrum to move the cuff engaging edge with respect to the bushing from a point that is remote from the cuffing clamp.

2. A suturing stapler according to claim **1** wherein the cuff engaging edge of each cuffing clamp is serrated.

3. A suturing stapler according to claim **1** wherein the cuffing clamps are secured to the forceps means by a bayonet type mounting.

4. A suturing stapler according to claim **1** wherein the cuff engaging edge and bushing surface are semi-circular and complementary.

5. A suturing stapler according to claim **1** wherein the cuffing clamps engage the cuff over 180° of arc.

6. In a medical stapler, the combination of a stapler section and an anvil section, hinge means between said sections operable for removably interengaging said sections in registry for performing suturing stapling, each section including a releasably closed bearing structure, two semi-cylindrical staple bushing-halves removably disposed in registry in the bearing structure of the anvil section, the bushing-halves in the bearing structure of each section completing a cylindrical bushing; each bushing-half having a centrally located semi-circular flange carrying a projection on one side thereof, each bearing structure defining two opposite recesses, that receive said projection for positioning the bushing-halves thereof in registry with the

flanges against the surfaces of each bearing structure to complete the bushing; latching means secured to each section operable for releasably engaging said flange and pressing it against the surface of the bearing structure, thereby securing the bushing-half thereof in the bearing structure, comprising a flat spring having a semi-circular flange engaging section at one end positioned to exert pressure against the flange and a wedge form slid engaging said spring, said wedge form slide being movable in one direction to lift the spring from the flange and release the bushing and said wedge form slide being movable in another direction to lower the spring on the flange thereby securing the bushing-half in the bearing structure.

7. The medical stapler of claim 6 wherein said hinge means comprises a pair of brackets affixed to said stapler and anvil sections; one of said brackets supporting a headed pin; the other of said brackets having a slot therein adapted to releasably engage said pin.

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